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Sondheim (Ambassadors) Theatre, West Street, London WC2H 9HD

Structural Stage D Report on the Proposed Redevelopment of the Theatre

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1.0 THE SITE AND ITS ENVIRONS

1.1 The Theatre was completed in 1913 on the site of several earlier buildings that were cleared to construct the Ambassadors and St Martin's Theatres. St Martins', on the other side of Tower Court was not completed until 1916.

1.2 There are 2 buildings that abut the Theatre on the West Side and each was constructed before the Theatre and are therefore assumed to be stable on their own account and have foundations at least as deep as the Theatre's. The Nonconformist Chapel at No 24 West Street was constructed in 1700 and the offices at 4-10 Tower Street were constructed at the end of the 19th Century.

1.3 An Archaeological report has been prepared for the site by RSK and John Earl has prepared a report on the conservation context.

1.4 There is an Asbestos register for the building prepared by Healthy Buildings International only identifying some medium risk pipe lagging in a basement light store and low risk fuse box insulation in the props room. Prior to any works commence a full intrusive demolition asbestos survey will be undertake by a suitable qualified specialist.

1.5 West Street and Tower Street are one way and have some on street parking spaces. The flow from each is from the direction of Shaftesbury Avenue. Tower Court is pedestrian only. The effect on the traffic flows and suggested construction sequence proposals during the works are addressed in the Construction Management Plan prepared by Conisbee and will be further addressed by Vectos transportation consultants.

1.6 The London Underground Northern line is 75m to the West and Piccadilly line 150m to the South so have no effect on the building. Neither Network Rail nor Cross Rail tunnels are in the vicinity either.

1.7 A utilities search was undertaken in advance of ground investigation works by RSK Environmental and the roads and footpaths on both Streets contain services as does Tower Court. These are identified in their report and supplemented by a GPR survey by Survey Design Services. The MEP Consultant Power Plan Solutions will deal with the statutory undertakers with respect to the any relocation necessary for the works.

1.8 The Ground conditions determined during the site investigation by RSK comprise:

- 2.2m Made Ground
- 2.1m Langley Silt (Brickearth)
- 1.3m Hackney Gravel (containing perched water near interface with clay only)
- London clay to depth

2.0 EXISTING CONSTRUCTION

2.1 The building appears domestic in scale as the solid masonry load bearing elevations are only about 9.0m above street level on each side. Other masonry walls around the building are load bearing including those around the stage house and there are no steel columns in common with other Sprague Theatres.

2.2 The floors and roofs to the front and back of house, auditorium roof and balconies comprise 'filler joist' construction supported on mild steel beams or trusses. Filler Joist construction comprises mild steel beams at roughly 900mm centres with concrete poured between them and above them by 25-50mm so the two materials work compositely together.

2.3 The stage house roof and supporting trusses are timber as is the grid, fly floors and stage. The stage is set 3.0m below street level and has a 2.5m under stage.

2.4 The back of the stalls adjacent to West Street are 3.0m below street level and the floor slopes 900mm down to the stage on a concrete ground bearing slab.

2.5 There are lightwells with masonry retaining walls to the street elevations around the perimeter of the building.

3.0 PROPOSED CONSTRUCTION

3.1 The theatre will be entirely reconstructed with the exception of the existing front wall on West Street. To achieve this and maintain stability of the wall and adjacent streets a particular sequence of works will be followed. The stages of these are described in section 4.0, the Outline Construction Sequence, initially developed by Conisbee and shown in sequencing sketches SSK101-108. These will be developed by the contractor once appointed. The site accommodation will initially be on the retaining structure to the front wall on West Street and the works and storage will all have to take place within the site as there are no peripheral areas for this.

3.2 The existing retained foundations will be enhanced using various underpinning techniques and, following demolition, a piled wall and foundations will be installed.

3.3 There will be about 1.3m excavation to new formation at the front and rear of the site and up to 2.5m in the centre to achieve the new desired profiles. RSK have undertaken a Basement Impact Assessment described in section 6.0.

3.4 Below ground concrete will constructed to water retaining standards but otherwise all damp and waterproofing solutions will be specified by the Architects.

3.5 The new superstructure construction comprises a steel frame with composite and insitu concrete floors, balconies and roofs to create the form indicated on Conisbee drawings.

3.6 Typical imposed loading capacities allowed for are:

- Roofs 1.5kN/sqm
- Plant platforms decks and rooms 7.5kN/Sqm (or specific loads)
- Rehearsal Rooms 5.0kN/sqm
- Stairs 3.0kN/sqm
- Balconies and Stalls seating 4.0kN/sqm
- Audience Slips and Galleries 4.0kN/sqm
- Stage 10.0kN/sqm
- Dressing rooms 2.5kN/sqm
- Front of House and circulation 5.0kN/sqm
- Ground floor construction capacity 10kN/sqm (during works)

3.7 Design coordination has been undertaken with MEP consultants Power Plan Solutions and allowance made for riser and duct layouts and plant arrangements provided.

3.8 Allowance has been made for the weights of structure and acoustic treatments identified by Gillieron Scott Acoustic Design.

4.0 OUTLINE CONSTRUCTION SEQUENCE

4.1.1 See suggested construction sequence sketches SSK101 - SSK108
4.1.2 Take squeezes of all historic plasterwork and remove and store main ceiling.
4.1.3 Soft strip internally and service diversions externally
4.1.4 Install mass concrete underpinning on party wall line
4.1.5 Temporarily infill light wells and install secant piled wall to perimeter, remove infill.
4.1.6 Set up temporary hoardings on Tower Street and Tower Court after removing all canopies and signage
4.1.7 Install any early piles required adjacent to front and rear walls using low headroom rig.
4.1.8 Install ‘Pynford beam’ type underpinning stools to front elevation on West Street.
4.1.9 Cast front ‘Pynford beam’ and slab integrally.
4.1.10 Introduce props to restrain front and rear walls where necessary.
4.1.11 Dismantle timber roof and grid over stage including stage
4.1.12 Set up concrete/brick crushing plant

4.1.13 Carefully remove upper section of proscenium wall and progressively demolish dressing rooms construction on Tower Street elevation in controlled way so that materials are segregated for reuse.

4.1.14 Filler joist floors to have concrete infill broken out and crushed.

4.1.15 Steelwork to be cut into manageable pieces and set aside for removal and recycling.

4.1.16 Masonry to be taken down and crushed to requisite sizing

4.1.17 Crushed material to be used to infill the site and supplemented to create a pile platform

4.1.18 Temporary works steel frame to be erected on West Street to restrain front elevation masonry.

4.1.19 Site Accommodation and welfare may be positioned on this frame and enclosed with mesh sheeting in agreed colours or motifs.

4.1.20 Demolition of area over front of house can commence as described for dressing rooms.

4.1.21 Roof, floors, and balconies are all filler joist construction supported on steel framing.

4.1.22 The inside of the retained front facade will be made good as lateral structure is carefully removed from it.

4.1.23 Records will be made of the construction as the engineering is similar to other theatres of the period and will be shared with other members of the Institution of Civil and Structural Engineers historical knowledge groups.

4.1.24 The building will be reduced to existing ground level and the crushed concrete and brickwork, supplemented with imported material will be used to form the piling platform and berms and ramps into the site.

4.1.25 The party walls will not be propped as the adjacent buildings pre-existed the theatre and must have been stable in their own right at that time. Protection measures will be taken to the parapets and wall faces to prevent water ingress.

4.1.26 After piling works are completed the pile platform will be removed and the site will be excavated to the new over site level.

4.1.27 Ground water may be encountered and this will be drained to a sump and temporarily pumped into the sewer network.

4.1.28 A ground slab shall be formed over the piles and retaining walls cast against the piled walls and underpinning, all using Caltite waterproof concrete or similar.

4.1.29 When this work is complete the need to pump ground water should ceased.

4.1.30 A tower crane will be erected to assist the construction process.

4.1.31 The steel frame erection can now commence including composite floors and insitu concrete walls and slabs where appropriate.

4.1.32 Cladding will progress but a vehicular access will be left onto Tower Street.

4.1.33 The stage floor and stalls will be constructed/propped to allow temporary site traffic and storage of materials due to limits space around the perimeter of the building

4.1.34 The building will be made watertight around which time the tower crane will be removed.

4.1.35 Lateral restraint and accommodation will be removed from West Street.

4.1.36 Plant platforms and package plant will be erected using mobile crane during temporary closure of Tower Street.

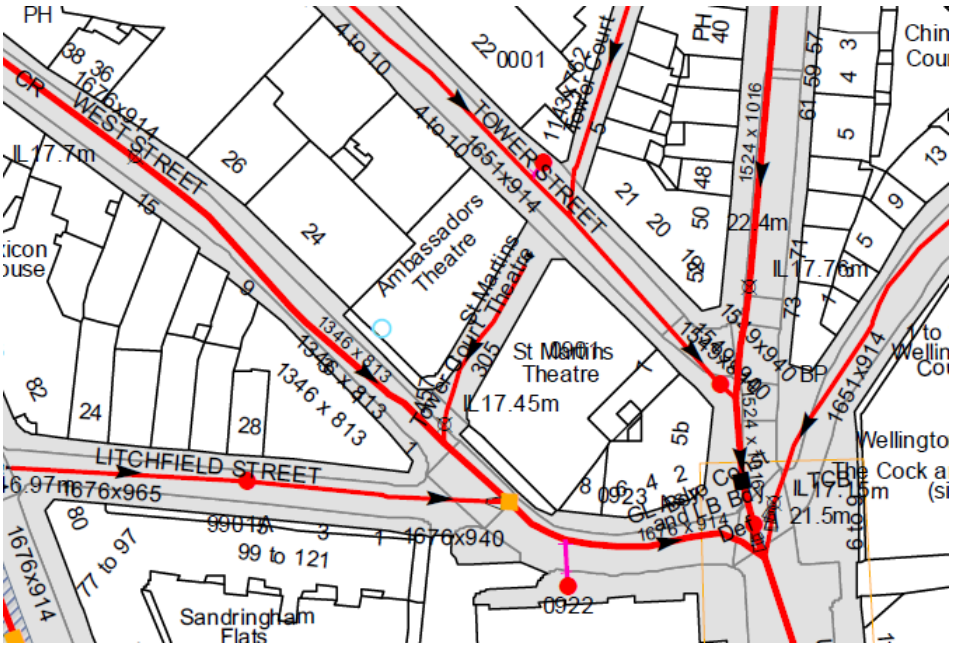
4.1.37 Internal fit out will progress with access and deliveries onto ground floor from Tower Street.

5.0 DRAINAGE & FLOOD RISK

5.1 Existing Drainage

5.1.1 A topographical survey was completed for the site in July 2014 which shows a combined surface and foul water system within the existing building draining via two 150mm diameter connections to the Thames Water sewers in West Street and Tower Street. There are currently two separate sump pumps, assumed to be for ground water, in the theatre basement.

5.1.2 The Thames Water asset maps have been obtained for the site. An existing combined Thames Water sewer (size 1346x813) runs from North West to South East along West Street. The invert level (IL) of a manhole to upstream of the site is 18.10 at a depth of 5.12m. There are no details for invert levels for manholes downstream of the site. A further combined Thames Water sewer (size 1651x914) runs from North West to South East along Tower Street. The invert level (IL) of a manhole to upstream of the site is 18.33 at a depth of 4.76m. There are no details for invert levels for manholes downstream of the site. There is a combined 305 diameter sewer running South in Tower Court which connects to the combined sewer in West Street. An extract from the records is shown in the Figure below.



5.1.3 The existing runoff characteristics are as follows:

Existing Runoff Characteristics		
M5_60 Rainfall Depth	20.0	mm
Ratio, r	0.44	
Total Site Area	548	m²
Existing Impermeable Area	548	m²
	0	%
1 in 1 year, Q_1*	1.8	l/s
1 in 100 year, Q_{100}*	5.6	l/s
Mean Annual Flow, Q_{BAR}*	2.2	l/s
Pre-Development Runoff Volume, $Vol_{M100-360}$	30	m³
*Based on modified rational method. 60 minute duration.		

5.2 Proposed Surface Water Drainage

5.2.1 For the new theatre it is proposed to re-use the existing drainage connections to the Thames Water sewers.

5.2.2 Initial discussions have taken place with Thames Water Developer Services who have confirmed that they have no objections if the existing connections to the sewers are re-used as long as the flows remain similar to the existing situation.

5.2.3 The initial Stage D report issued 23rd December 2014 was based on earlier advice from Thames Water that they would not require any runoff reduction from the site, providing that the impermeable area remains the same. However, this predated a change in national planning policy guidance and initial pre-planning consultation has identified that:

- A SUDS strategy will need to be submitted with the planning application targeting a green field run off rate for all events up to a 1 in 100 year event. If this cannot be achieved then a minimum of 50% reduction in runoff will need to be targeted.
- Rain water/grey water harvesting will need to be incorporated into the scheme

5.2.4 The Camden Development Policies Document (paragraph 23.7) states that the most sustainable methods of SuDS will be sought wherever possible. The London Plan Policy 5.13 requires SuDS unless there are practical reasons for not doing so

5.2.5 An effective SuDS system needs to follow the SuDS Management Train. This means capturing and disposing of as much rainfall at source as possible (using a multiple SuDS components to manage rainfall across the site. The management train should generally follow this hierarchy:

- **Source Control**
- **Site Control**
- **Regional Control**

5.2.6 Source control methods are often the most simple and effective methods of reducing runoff from existing sites, especially small sites where Greenfield rates cannot be achieved. In central London the existing sewerage system is at capacity after only a few millimetres of rainfall and regularly overflows into the Thames. Source control methods that intercept rainfall before it enters the drainage system therefore have significant benefit. Site control methods, such as attenuation tanks, are of less benefit as the sewerage system as they only reduce the peak flow from larger storms when the sewers would already be full and overflowing.

5.2.7 A SuDS design will also need to consider failure of the drainage system, due to capacity being exceeded or physical faults, by ensuring flood flows are directed away from buildings.

5.2.8 Given that the site has been and will remain fully developed with negligible external space most SuDS methods can be dismissed easily. For example, there is no space for small rain gardens and infiltration drainage (soakaways) would be impossible. The following methods have been assessed in greater detail.

Method	Assessment
Green Roofs	The proposed building will have a mansard roof and is situated within a conservation area. The building has been designed to be sensitive to the area and the original theatre. For these reasons a green or brown roof is not thought to be appropriate for this site. There is an area of the roof where a green roof could be installed, however this is to be occupied by a large amount of plant and it will not be feasible to fit in a green roof around this.
Permeable Pavements	The only area where permeable paving could be laid is at the front entrance of the building. This measures 51m² in area but is mostly covered by a canopy, so would not receive rainfall, and is situated entirely above a basement slab. The site is within a conservation area so it is unlikely that permeable paving would be an acceptable surfacing material.

Rainwater Harvesting	Rainwater harvesting has been discounted for the following reasons: 1. The site is completely occupied by a large basement and the only place a harvesting tank could be located is beneath the basement slab. This would require significant excavation and use of reinforced concrete that will probably offset any energy saved through the use of harvesting. 2. The water demand for the building is relatively low so the volume of harvesting required would not provide a significant reduction in runoff volume. 3. The cost of installing and maintaining a system is high relative to the sustainability benefits it would provide. A final decision on the inclusion of rainwater harvesting will be made at the detailed design stage following assessment by the M&E engineers.

5.2.9 The only feasible method of reducing surface water runoff would be to provide below ground attenuation in a tank. Based on a 5l/s restriction an attenuation volume of 13.5m³ would be required for the 1 in 100 year critical storm with a 30% allowance for climate change.

5.2.10 Any tank would have to be located beneath the basement slab, as there is no external space, which is below the level of the Thames Water sewers. This would result in all surface water from site being pumped up to a higher level. There are several reasons why this is not an appropriate option:

- The ongoing operation and maintenance costs of the pumps will be high and energy intensive. Pumping is unsustainable and should always be minimised where possible.
- By routing surface water into the basement and relying on mechanical plant for drainage the risk of flooding would actually be increased.
- In line with current best practice a 5l/s minimum discharge would be used. This is only a slight decrease from the existing 1 in 100 year rate of 5.6l/s. It is also difficult to achieve a complex control regime using pumps therefore the 1 in 1 year discharge rate may not be lower than the existing.
- There would be no interception of small rainfall events, as discussed above, and no reduction in runoff volume. The runoff rate would only be reduced for more extreme events when the sewers would already be full and overflowing through the combined sewer overflows (CSOs).

5.2.11 Given the constraints of the site, and that Thames Water have no requirement for runoff reduction, it is not thought to be practical or beneficial to implement SuDS techniques in the new development. It is not possible to achieve a meaningful reduction in runoff and it is not possible to incorporate any source control methods without compromising the design of the historic building. It is proposed to simply connect the new rainwater pipes to the existing system and discharge surface water via gravity.

5.2.12 For the reasons discussed above the new development will not incorporate SuDS. However, there will be zero increase in impermeable area, and therefore no detriment to the existing system, and the proposals are in line with national, regional and local planning policy

5.3 Proposed Foul Water Drainage

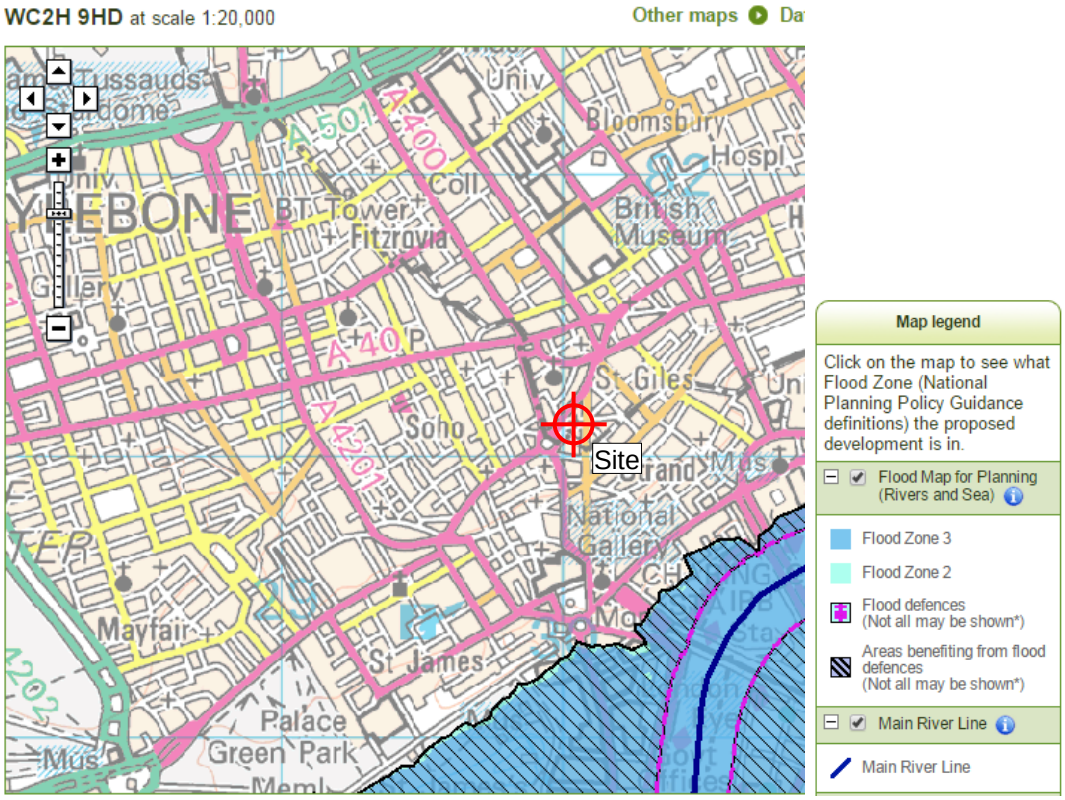
5.3.1 It is proposed to use the existing combined connections to the Thames Water sewers.

5.3.2 The foul drainage in the proposed basement will be pumped up to the required level and a suitable volume of emergency storage will be provided in line with Building Regulations. Efforts will be made to ensure that foul drainage from the upper floors can drain via gravity.

5.4 Flood Risk

5.4.1 Fluvial Flooding

The nearest reaches of the River Thames is located south 850m south of the site. The site is located at a higher elevation of 18.00m AOD generally and therefore lies within Flood Zone 1, outside the flood risks areas associated with the River as can be seen below from the EA Flood Risk Map.



Environment Agency Flood Map.

5.4.2 Tidal Flooding

The site is located 850m from the Thames therefore it is not at risk from Tidal Flooding

5.4.3 Overland Flooding

Overland flooding can occur when high intensity rainfall overwhelms man made drainage systems or cannot soak into the ground. Excess water can flow across the ground following the contour gradient and cause flooding downstream. It is exacerbated by steep topography. The information available (Strategic Flood Risk Assessment and Flood Risk Management Strategy) does not state that the site is an area at risk from overland flooding.

5.4.4 Groundwater Flooding

Groundwater flooding occurs when the water table rises to the ground surface and inundates low lying areas. The Flood Risk Management Strategy states that the risk from groundwater flooding in Camden is uncertain and more information is required to build up an understanding of it; however currently the Environment Agency Maps show that the site is not at risk from groundwater flooding.

The new basement will be constructed to the latest standards (BS 8102) and is likely to incorporate a cavity drainage system to mitigate against groundwater ingress.

5.4.5 Sewer and Surface Water Flooding

Thames Water surface water sewer, foul water sewer and combined water sewer flooding data indicates that no flooding events occurred in the vicinity of the site.

The new basement will incorporate foul water pumps so there is little risk of flooding to the lower levels due to sewer surcharging.

5.4.6 Flooding from Artificial Sources

The site is not located at close proximity to any reservoirs, canals or other artificial sources. It is considered that the site is not at risk from flooding from artificial sources.

5.4.7 Overall Flood Risk

The site is thought to be at **very low** risk from flooding.

6.0 BASEMENT IMPACT ASSESSMENT

6.1 Following a full ground investigation RSK have prepared a basement impact assessment in accordance with Camden Planning Guidance for Basements and Lightwells, CPG4 (Nov 2013) and Camden Geological, Hydrogeological and Hydrological Study prepared by ARUP (Nov 2010). Attention is also given to policy DP27. RSK's findings and conclusions are summarised in Project report 27259-04(01) rev1.0, 7th March 2016, as follows:

6.2 The existing and proposed development are as described in Sections 2 and 3. There will be about 1.3m excavation at the front and rear of the site and up to 2.5m in the centre to achieve the new formation.

6.3 The ground and ground water conditions are as described in Section 5 of RSK's Geotechnical site Investigation and section 4 of their BIA.

6.4 Screening and scoping identified:

- Subterranean (ground water) – No potential impacts beyond scoping stage.
- Surface flow and flooding – no potential impacts identified beyond scoping stage
- Land Stability - potential ground movement impacts due to:
    - Retaining wall installation and ground excavation
    - Elastic heave of London Clay due to excavation
- The following nearby structures are at potential risk;
    - Adjacent highways to Tower and West Streets

- Adjacent buildings to the West
- St Martin's Theatre to East

6.5 Structural Stability - RSK have undertaken studies:

- Movement analysis during retaining wall installation and basement excavation in accordance with CIRA C580 concludes all structures fall into 'Category 0' (Negligible Damage) on the Burland categories, which is acceptable.
- Similarly the effect from heave of the basement excavation has been numerically modelled during demolition and excavation and then reloading with new construction. Within the building this results in heave at the centre of 28mm and zero approaching the basement wall. St Martin's theatre is likely to experience heave of 5mm and the buildings to the West of the party wall about 17mm. Following re-loading settlements of 4mm are expected in the centre of the site and 1mm and 4mm for St Martin's and the buildings to the West respectively.
- They concluded that the short term heave movements combined with movements predicted for secant bored pile wall installation and excavation in front of the wall, and with the small tensile horizontal stresses and deflection ratios, are unlikely to be damaging to the identified adjacent structures. Further calculations may be undertaken as detailed design progresses.

6.6 The impacts to neighbours from demolition and construction are addressed in the preliminary Construction Management Plan prepared by Conisbee.

- The appointed contractor will be part of a considerate constructors scheme
- Demolition will be in accordance with the Demolition Protocol

6.7 Sustainable Construction

- All salvaged steel work will be recycled
- Existing concrete and masonry will be crushed and used to form temporary berms and the pile mat before being removed for similar use on other projects.
- All reinforcement is made from recycled steelwork.
- Concrete will be produced locally and contain a proportion of recycled materials.

6.8 Planning and design Considerations

- These aspects and being addressed by Montague Evans in association with Aedas Arts Team.
- A conservation report as been prepared by John Earle.

6.9 An appropriate monitoring regime shall be implemented during the construction of the basement in order to monitor any ground movements against those predicted by the geotechnical specialist. This may include the use of targets fixed to adjoining properties to measure 3D horizontal and vertical movements and the use of inclinometers to measure horizontal movement of the piles. A “green, amber, red “ system will be employed with trigger levels agreed in advance with the party wall surveyors based on specialist geotechnical advice. An action plan shall be put in place that will be implemented should any trigger levels be exceeded during the construction works.